INVESTIGATION ON ROAD DAMAGE DUE TO VEHICLE OVERLOADING IN IPOH STATE ROAD

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A project report submitted in partial fulfilment of the
requirements for the award of the degree of
Master of Engineering (Civil)

Faculty of Civil Engineering

JUNE 2017

ACKNOWLEDGEMENT

Alhamdulillah, all praise is due to Allah S.W.T. Due to His blessing, I was able to complete this master project in time.

I wish to express my sincere gratitude to my supervisor, Professor Dr. Mohd Rosli bin Hainin for his advices, patience and guidance throughout the process of completing this research. He also has convincingly conveyed the spirit in regards to complete this research.

My utmost appreciation goes to En. Mohd Fazlie from Empayar Indera Sdn Bhd for a huge favour in facilitating the collection of data and information.

Also a special thanks to my beloved family members for their prayers and fellow friends for their support especially Siti Farhanah who always give helping hands when needed.

To all of them, I am truly grateful.

ABSTRACT

Traffic load is a major factor in thickness design due to the main function of pavement which is to resist traffic load. Although efforts to repair the road damage have been done continuously, the recovering effects are almost meaningless if the road is continuously receiving overloading from vehicles. Issues of road damage due to vehicle overloading have been addressed by most agencies in developing countries. However, there is no available study to address this issue on Perak state road. Therefore, this research aims to investigate the effects of vehicle overloading to road damage at Ipoh state road by reviewing the adequacy of existing pavement thickness to withstand current overloading and the reduction of road pavement service life due to overloading using AASHTO and Arahan Teknik (Jalan) 5/85. The selected study area was at Jalan Tuanku Abdul Rahman, Ipoh. Data were employed which acquired from traffic count survey, axle load survey, coring test and dynamic cone penetrometer test. Assessment on existing vehicle loads revealed that more than 50% of vehicles from 4-axle, 5-axle and 6-axle exceeded the maximum permissible gross vehicle weight (PGVW). The analysis on the Equivalency Factor (E.F.) shows that primary and secondary directions have gained E.F. value of 2 and 3 times higher than the E.F. design value respectively. This also denotes that additional overlay pavement thickness is required which is about 50mm and 70mm for primary and secondary direction respectively to ensure the target design life is archived. This study also discovered the reduction of service life of 6 and 7 years for both directions respectively.

ABSTRAK

Beban trafik adalah merupakan faktor yang penting dalam proses merekabentuk ketebalan jalan disebabkan fungsi utama lapisan turapan jalan adalah untuk menanggung beban trafik. Walaupun usaha untuk membaiki kerosakan jalan dilaksanakan secara berterusan, namun kesan pemulihannya tidak akan berkesan jika jalan itu masih berterusan menerima beban trafik yang berlebihan. Masalah berkaitan kerosakan jalan yang disebabkan oleh beban trafik berlebihan telah mendapat perhatian dari kebanyakan agensi dari negara membangun. Namun, sehingga kini tiada kajian terperinci berkaitan masalah ini dijalankan di jalan-jalan negeri di Negeri Perak. Oleh itu, kajian ini bertujuan untuk mengkaji kesan beban trafik berlebihan ke atas kerosakan jalan di jalan negeri di Ipoh dengan meneliti kecukupan ketebalan turapan sedia ada untuk menampung muatan trafik semasa serta kadar pengurangan jangka hayat turapan yang disebabkan oleh beban trafik berlebihan berpandukan AASHTO dan Arahan Teknik (Jalan) 5/85. Kawasan kajian yang terlibat adalah di Jalan Tunku Abdul Rahman, Ipoh. Data yang digunakan diperolehi daripada kerja tinjauan lalulintas, tinjauan beban gandar, ujian korekan dan ujian penetrometer kon dinamik (DCP). Tinjauan pada data beban gandar menunjukkan bahawa lebih 50% daripada bilangan kenderaan 4-gandar, 5-gandar dan 6-gandar yang ditimbang telah melebihi had maksimum berat kasar kenderaan (PGVW) yang dibenarkan. Analisis pada *Equivalency Factor* (E.F.) menunjukkan bahawa dari arah primer dan sekunder masing-masing telah mengalami kenaikan nilai E.F. sebanyak 2 dan 3 kali ganda lebih tinggi dari nilai E.F. rekabentuk. Ini juga menunjukkan bahawa ketebalan lapisan turapan perlu ditambah iaitu sekurang-kurangnya 50mm dan 70mm tebal masing-masing untuk arah primer dan sekunder. Selain itu, kajian ini juga telah menunjukkan pengurangan jangka hayat sebanyak 6 dan 7 tahun masing-masing untuk arah primer dan sekunder.

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LIST OF ABBREVIATIONS

SYMBOL	DESCRIPTION
AASHTO	*American Association of State Highway and Transportation Officials*
ADT	*Average Daily Traffic*
ATJ	*Arahan Teknik (Jalan)*
CBR	*California Bearing Ratio*
DCP	*Dynamic Cone Penetration*
E.F.	*Equivalency Factor*
ESA	*Equivalent Standard Axle*
HPU	*Highway Planning Unit*
IRI	*International Roughness Index*
MAL	*Maximum Axle Load*
MEPDG	*Mechanistic Empirical Pavement Design Guide*
PGVW	*Permissible Gross Vehicle Weight*
RTVM	*Road Traffic Volume Malaysia*

LIST OF SYMBOLS

an	-	Structural layer coefficient
a_1	-	Structural coefficient for asphalt
a_2	-	Structural coefficient for Sub-base
a_3	-	Structural coefficient for Road base
dn	-	Thickness of each structure pavement
h_1	-	Surface thickness
h_2	-	Road base thickness
h_3	-	Sub base thickness
n	-	Service life
P_c	-	Percentage of commercial vehicles
r	-	Annual traffic growth rate
T_A	-	Required equivalent thickness
T_A’	-	Corrected equivalent thickness
T_D	-	Designed equivalent thickness
T_E	-	Existing pavement thickness
T_o	-	Overlay thickness
V_o	-	Initial annual commercial vehicle
W_{18}	-	Predicted traffic load
w_{18}	-	Traffic load in basic year

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CHAPTER 1

INTRODUCTION

Pavements are engineering structure which economically designed to withstand traffic loading and climate action with minimal deterioration (Hudson et al., 2003). Pavements may encounter different mode of failures depending on its structural types which caused by specific factors. For example, flexible pavement may experience fatigue failure, rutting, undulating, etc. while rigid pavement may experience faulting edge, cracking, etc. All these mode of failure are caused by several factors such as heavy traffic loading, climate effect, drainage effect, material properties and inadequate design thickness (Hudson et al., 2003).

Among all these factors, heavy traffic loading has contributed significantly to pavement damage. According to Yu et al. (1998), the magnitude and configuration of vehicle loads in conjunction with environmental factor have imposed significant effect on the induced tensile stresses within flexible pavement.

Although heavy vehicle load is subjected to high stresses causing pavements damage, not all trucks have the same damaging effects. The damaging factors depend on speed, wheel loads, number and location of axles, load distributions, type of

suspension, number of wheels, types of tire, inflation pressure and many other factors (Gillespie et al., 1993).

1.1 Problem Statement

Ipoh has been known as the busiest town in Perak State. It is located at the heart of Perak under District of Kinta. Hence it has quite a numbers of inter-city road networks which connects Sungai Siput in the North of Perak, Simpang Pulai in the South, Batu Gajah in the West, Tambun in the North-West, Cameron Highland in the East and Jelapang in North-East. Other than that, crossing through Ipoh is the North-South Expressway with two (2) main exits i.e. in the South (Ipoh Selatan Interchange) and North (Ipoh Utara Interchange). In conjunction with this, obviously the road has been used by numbers of vehicles with various types and the pavement may have been imposed by high stresses from overloaded vehicle which causing road damage.

Based on records of previous maintenance works, it was found that several rehabilitation works has been carried out for the past 3 years. In addition, Notice of Defect by maintenance concessionaire's company has also been issued to local authorities regarding the pavement damage and the necessity to conduct repairing work. This has been further proved by the records of pothole defect found on the road pavement.

This phenomenon has indicated that the road may experience fatigue failure due to rapid overloading imposed on pavement surface. This also shows that the pavement could not last longer as per design life and the pavement service life has become shorter.

1.2 Research Objectives

The aim of this study is to analyse the effect of overloaded heavy vehicle to road pavement damage. The objectives were detailed as follows:

a) To determine the current traffic composition of the road

b) To assess the percentage of overloading vehicle according to different types of vehicle based on local Weight Restriction Order and the damaging factor from equivalency factor (E.F.)

c) To calculate the adequacy of existing pavement thickness to withstand current overloading traffic

d) To estimate the reduction of pavement service life due to overloading

1.3 Scope of Work and Limitation

In this study, the research scope and limitations are as follows:

a) The case study was conducted at one of the major State Road in Ipoh, i.e. Jalan Tuanku Abdul Rahman (also known as Jalan Kuala Kangsar). It has about 5km length of flexible pavement road and consists of two (2) and three (3) carriageways at both directions. The road links between Federal Road FT001, state administrative centre of Perak and mixed development area (business and residential)

Figure 1.1: Ipoh region map

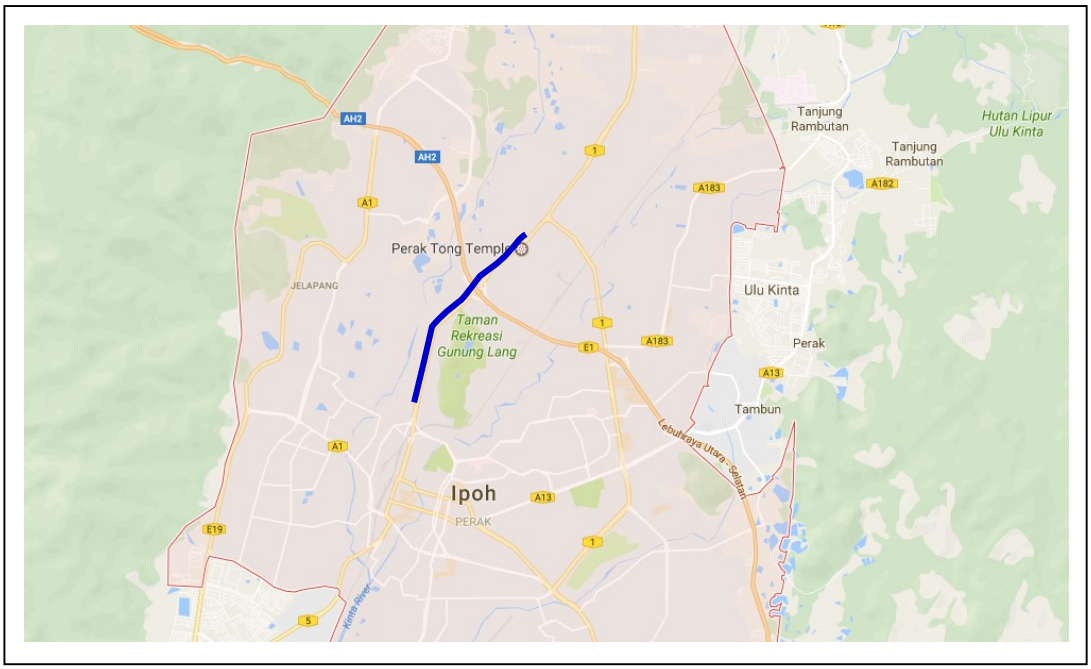

Figure 1.2: Location of Jalan Tuanku Abdul Rahman road segment

b) The calculation of pavement service life was based on Average Daily Traffic (ADT) and equivalent standard axle (ESA) of overloaded vehicle

c) The guideline used in this study are AASHTO 1993 and Arahan Teknik (Jalan) 5/85

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